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which is four feet five inches high, and in its broadest part at the base four feet six and a half inches in circumference, and an exact copy of the inscription:

Mr. Griffith read a notice by Mr. Hemans, of a Dislocation in the Calp near Killester.

The President, on presenting to Dr. Kane the Cunningham Medal, awarded to him for his Researches on the Nature of Ammonia, gave an account of the progress of his discoveries.

It is now my duty to inform you, that a Cunningham Medal has been awarded by the Council to Dr. Robert Kane, for his Researches on the Nature and Constitution of the Compounds of Ammonia, published in the First Part of the Nineteenth Volume of the Transactions of this Academy. It would, indeed, have been much more satisfactory to myself, and doubtless to you also, if one of your Vice-Presidents, who is himself eminent in Chemistry, had undertaken the task which thus devolves upon me, of laying before you a sketch of the grounds of this award; but at least, my experience of your kindness encourages me to hope, that while thus called upon officially to attempt the discharge of a duty, for which I cannot pretend to possess any personal fitness, or any professional preparation, I shall meet with all that indulgence of which I feel myself to stand so much in need.

Although, in consequence of the variety of departments of thought and study which are cultivated in this Academy, and the impossibility of any one mind's fully grasping all, it is likely that many of its members are unacquainted with the details of chemistry, yet it has become matter of even popular knowledge, that in general the chemist aims to determine the constitution or composition of the bodies with which we are surrounded, by discovering the natures and proportions of their elements. Few need, for instance, to be told that water, which was once regarded as itself a simple element, and which seems to be so unlike to air, or fire, or earth, has been found to result from the intimate union of two different airs or gases, known by the names of oxygen and hydrogen, of which the one is also, under other circumstances, the chief supporter of combustion, is an ingredient of the atmosphere we breathe, and is closely connected with the continuance and healthful action of our own vital processes, by assisting to purify the blood, and to maintain the animal heat; this same gas combining also, at other times, with some metals to form rusts, with others acids, with others again alkalies and earths, entering largely into the composition of marble and of limestone, and, in short, insinuating itself, with a more than Protean ease and variety, into almost every bodily thing around us or within us; while the other gas which contributes to compose water, though endowed with quite different properties, is also extensively met with in nature, especially in organized bodies, and in particular occurs as an element in that important substance, on the confines of the mineral and organic kingdoms, to which the Researches of Doctor Kane relate; ammonia being, as all chemists admit, a compound of hydrogen and nitrogen, which last-named gas is well known as being the other chief ingredient (besides oxygen) of atmospheric air.

Again, it is generally known, to those who take an interest in physical science, as a truth which is almost the foundation of modern chemistry, that the elements of bodies of well-marked and definite constitutions, such as pure (distilled) water, or dry (anhydrous) ammonia, are combined, not in arbitrary, but in fixed and determined proportions; for example, the oxygen contained in any quantity of pure water weighs exactly, or almost exactly, eight times as much as the hydrogen contained in the same quantity, but occupies (when collected and measured) a space or volume only half as great; and the nitrogen contained in any given amount of dry ammoniacal gas, is to the hydrogen with which it is combined, by weight as 14 to 3, and by volume in the proportion, equally fixed, of 1 to 3.

Yet such results as these, respecting the constitution of compound bodies, however numerous and accurate they may be, are still not sufficient to satisfy the curiosity, or to terminate the researches of chemists. They aspire to understand, if possible, not only the *ultimate* constitution of bodies, or the elements of which they are composed, and the proportions of those elements, but also the *proximate* constitution of the same bodies, or the manner in which they arise from other intermediate and less complex compounds. Water, for instance, is believed to enter, in many cases, into composition with other bodies, *as water*, not *as* oxygen and hydrogen. Has ammonia any such component, which itself is composite? It is admitted to consist of one volume of nitrogen, combined with three of hydrogen. Can any order be discovered in this combination, any proximate constituent, any simpler and earlier product, from which the ammonia is afterwards produced? Until experiments decide, it appears not impossible, may seem even not unlikely, that nitrogen *may* combine (more intimately than by mere mixture) not only with thrice but with twice or once its own volume of hydrogen, and that thus other substances *may* be formed, from which, by the addition of new hydrogen, ammonia *may* result. It is interesting, therefore, to inquire whether either of these conceived possibilities is actually realized in nature; whether these two important gases do ever actually combine with each other in either of these two proportions. In the symbolic language of chemists, as usually written in these countries, the compound NH_3 is well known, being no other than ammonia ; but does NH* or does NH_2 exist?

An eminent French chemist, M. Dumas, in examining a substance, which he called oxamide, and which was one of the results of the action of oxalic acid on ammonia, was led to the conclusion, that the last mentioned compound of nitrogen and hydrogen, namely NH_2, does really exist in nature, and he proposed for it the name of *amide.* The same chemist considered it also to exist in the substance formed by heating potassium in ammoniacal gas ; and the same combination, amide, had been (I believe) regarded as a proximate constituent of certain other compound bodies, such as urea, sulphamide, and carbamide, before Dr. Kane's researches on the White Precipitate of Mercury. Yet it has been judged by Berzelius, that the investigations of Dr. Kane have assisted in an important degree to establish the actual existence (der wirklichen existenz) of amide, or of *amidogene* (as Kane prefers to call it, from its analogy with oxygen and cyanogen), and have thrown much light upon its chemical history and relations.

In fact, the body *oxamide*, which seems to have first led Dumas to infer the existence of amide, was one of those organic compounds, respecting which it has often been found difficult, by chemical inquirers, to pass with confidence from the *empirical* to the *rational* formula; from the knowledge of the *ultimate* elements (or of those which are at present to be viewed as such), and of the proportions in which they combine, to a satisfactory view respecting the *proximate* elements, or intermediate and less complex combinations on which the final result depends. Oxamide may be, and was considered to be, *probably* composed of amide and carbonic oxide (in the foregoing notation, $NH_2+C_2O_2$); but it was perceived to admit also* of being *possibly* compounded of nitric oxide and a certain combination of carbon and hydrogen ($NO_2+C_2H_2$); or of cyanogen and water ($C_2N+H_2O_2$). And even the amidides of potassium (KNH_2) and of sodium ($NaNH_2$), have, from the energetic affinities of those metallic bases, been thought to prove less decisively the existence of amidogene itself, than the amidide of mercury ($HgNH_2$) discovered by Dr. Kane, in his analysis of the white precipitate of the last mentioned metal. (Trans. R. I. A., vol. xviii. part iii.)

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* The compound NH, or as it is otherwise better written, HN, has been suspected to exist, as one of the proximate elements of melamine and of some connected bodies. See Gregory's edition of Turner's Chemistry, 1840, page 757.

Although this precipitate had been long known, and often analyzed, erroneous views (as they are now regarded) were entertained respecting its composition, and it had, for instance, been supposed to contain oxygen, till Kane pointed out the absence of this element, and showed, with a high degree of probability, that the proximate elements were the chloride and the amidide of mercury; white precipitate being thus a chlor-amidide of that metal ($HgCl+HgNH_2$, if the Berzelian equivalent of mercury be adopted, instead of its double). Ullgren, a friend of Berzelius, obtained the chemical prize from the Swedish Academy of Sciences, for the year 1836, for a paper in which, having with great care repeated and varied the experiments, he confirmed this and other connected results of our countryman; and Berzelius himself, in his Report read to the above-mentioned Academy in 1837, on the recent progress of the Physical Sciences in Europe (to which Report allusion has been made above), expressed his opinion that these researches of Kane were among the most important of the preceding year.†

In the essay for which your Council have awarded the present prize, Dr. Kane has pursued his researches on ammonia, and has shown, with apparently a high probability, that there exist amidides (though not yet insulated) of other* metals besidesm ercury, especially of silver and copper; that is, combinations of these metals with the proximate element amide or amidogene. He has also given, in great detail, a series of analyses performed by him on a large number of compound bodies, of which some had been imperfectly examined before, while others were discovered by himself. But as it would lead into far too great length, and too minute detail, if any attempt were made at present to review these laborious processes of analytical chemistry, and as indeed they derive their chief philosophical interest from the views with which they have been associated, it may be proper to attempt no more than a very brief (I fear that it will also be a very inadequate) sketch of those views.

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* L'Oxamide peut donc, à volonté, être considérée comme un composé de cyanogène et d'eau, ou bien comme un composé de deutoxide d'azote et d'hydrogène bicarboné, ou bien enfin comme un composé d'oxide de carbone et d'un azoture d'hydrogène différent de l'ammoniaque.—Dumas, sur l'Oxamide, &c. Annales de Chimie et de Physique, tome xliv. page 142.

† Diese Untersuchungen von Kane gehören meiner Ansicht nach zu den wichtigeren des verflossenen Jahres.—Wöhler's German Translation of Berzelius's Report, Jahres-Bericht über die Fortschritte der physischen Wissenschaften, 17th year, page 179. (Tübingen, 1838).

Dr. Kane considers that in ammonia, which, in the usual language of chemists, is said to consist of one atom of nitrogen and three atoms of hydrogen, one of these atoms of hydrogen is more loosely combined than the two others with the nitrogen, so as to be capable of a comparatively easy replacement, by many, perhaps by all, of the metals, as well as by organic radicals; the other two atoms of hydrogen being *already*, in the ammonia itself, and not merely in the products of such replacement of hydrogen by metals, combined in a particular way with the one atom of nitrogen, so as to form that substance named amide or amidogene, which was detected by Dumas (as has been mentioned) in performing the analysis of oxamide. From Dr. Kane's own study of the combinations of this substance amidogene (H_2N), with metals, he infers it to be a compound radical of feebly electro-negative energy, analogous to that important one cyanogen (C_2N), of which the discovery by Gay-Lussac has exercised so powerful an influence on modern chemistry. He considers this radical, amidogene, as existing ready formed, in combination with hydrogen, in ammonia; which latter substance is thus, according to him, to be regarded as *amidide of hydrogen;* and as, in this respect, analogous to water, and to the hydrocyanic, hydro-sulphuric, and muriatic acids, that is, to the oxide, cyanide, sulphuret, and chloride of hydrogen; from all of which bodies it is possible, as from ammonia, to expel an atom of hydrogen, and to replace it by an atom of metal,—if indeed hydrogen be not (as there seems to be a tendency to believe it to be) itself of metallic nature, notwithstanding its highly rarefied form. By developing this view of the constitution and function of ammonia, Dr. Kane has offered explanations of a large number of replacements of that substance by others, some of which replacements (I believe) were known before, while many have been discovered by himself.

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* Dr. Kane has since made it probable that there exist amidides of palladium and platinum also. (Phil. Trans. 1842, part ii.)

One of the most remarkable points in Dr. Kane's views is the way in which he considers the ordinary salts of ammonia. Many of these are known to contain an atom of water, the existence of which led to the proposition of the very remarkable theory by Berzelius, of the existence in them of a compound metal *ammonium*, which has not indeed been insulated, but has been found to form, in combination with mercury, a certain metallic amalgam. Dr. Kane looks upon these salts as double salts of hydrogen. He considers them to contain ammonia ready formed, united with a hydrated acid or with a hydrogen acid. He seeks to establish the similarity of the common ammoniacal salts to those complex metallic amidides, whose nature he has developed by analysis.

Thus, for example, the well-known body, sal-ammoniac, is, in the Berzelian view, regarded as chloride of ammonium; but, in the view put forward by Dr. Kane, it is chlor-amidide of hydrogen. The former view supposes that the ammonia robs the hydrochloric acid of its hydrogen, to form, by a combination with it, a metallic base, NH_4, with which the chlorine unites; as this last element combines with the metal sodium, in the formation of common salt. The latter view supposes that in the action between hydrochloric acid and dry ammoniacal gas, there is no separation of the chlorine from the hydrogen,—no breaking up of a previously existing union,—no overcoming of the affinity which these two elements (chlorine and hydrogen) have for each other; but an exemplification of a general tendency of chlorides, oxides, and amidides of the same or similar radicals, to unite, and form chlor-oxides, chlor-amidides, or oxamidides. Sal-ammoniac is, according to Kane, a double haloid salt; he looks upon it as being a compound exactly analogous to the white mercurial precipitate, which was first accurately analyzed by himself; the one being $HCl + HAd$ (if Ad be the symbol of amidogene), while the other is $HgCl + HgAd$, so that the mercury in the latter takes the place of the hydrogen in the former.

It was, however, in the oxysalts, such as the sulphate of ammonia, that the presence of an atom, or equivalent, of water, or at least of the elements required for the composition of such an equivalent, appears to have suggested to Berzelius the theory, that what seemed to be hydrate of ammonia ($NH_3 + HO$) was really oxide of ammonium ($NH_4 + O$). There are, undoubtedly, many temptations to adopt this view, besides the high reputation of its propounder. One is, that it assimilates the constitution of sulphate of ammonia to what seems to be regarded by the greater number of modern chemists, as the probable constitution of other sulphates, nitrates, &c., for example, the sulphate of iron. When green vitriol is to be formed by the action of sulphuric acid upon iron, it is requisite to dilute the acid with water, before the action will take place. The hydrogen of the water then bubbles off, but what becomes of the oxygen which had been combined with it? Does it combine immediately, and as it were in the first instance, with the iron, to form oxide of iron, on which the anhydrous sulphuric acid may act, to produce *sulphate of oxide* of iron, according to the view which seems, till lately, to have been adopted: or does this oxygen, from the water, combine rather with the sulphuric acid to produce a sort of oxide thereof, and does this *sulphat-oxygen* act on the pure metallic iron to form with it a *sulphat-oxide*, as many eminent chemists now appear to think? Whatever may be the final judgment of those who are entitled to form opinions on questions such as these, it cannot, I conceive, be justly said, that the questions themselves are unimportant. They touch on points connected with the philosophy of chemistry, are essentially connected with its theory, and cannot always be without an influence upon its practice.

Now according to the Berzelian view of sulphate of ammonia, that is the salt produced by the mutual action of sulphuric acid, water, and ammonia, this salt is properly a sulphat-oxide of the compound metal ammonium ($NH_4 + SO_4$), in the same way as green vitriol, on the view last mentioned, is sulphat-oxide of iron

($Fe + SO_4$), or as sulphate of potash is sulphat-oxide of potassium ($K + SO_4$), and this analogy is doubtless pleasing to contemplate.

Dr. Kane does not entirely reject this Berzelian theory of ammonium; he acknowledges that the substance NH_4, which he regards as *subamidide of hydrogen*, and compares to some suboxides, possesses metallic properties, and is a proximate constituent of certain compounds, especially of the ammoniacal amalgam; but he conceives that the evidence for the existence of ammonia itself, in many of the ammoniacal salts, is too strong to be resisted: and he looks upon the hydrated ammonia, which is found to combine with sulphuric and other oxacids, as being not, in general, oxide of ammonium, but *oxyamidide of hydrogen;* the sulphate of ammonia being thus a bibasic compound, of which one base is ammonia, while the other base is water.

Between the conflicting opinions of such men, supported each by powerful arguments and analogies,—and it will easily be conceived that in so short a sketch as this, and upon such a subject, it has been found impossible by me to mention even the names of all the eminent chemists whose experiments and writings should be studied, by persons inquiring for themselves,—not only do I not venture to express any judgment of mine, but I conceive also that your Council did not desire to express on their part any decision. To justify the present award, it was, I believe, deemed by them sufficient, that great research and great talents had been brought, in the investigations of the author to whom that award has been made, to bear on an important subject, which has derived, from those investigations, an additional degree of importance. Whatever may be the final and unappealable judgment of those persons who shall, at some future time, be competent and disposed to pronounce it, we need not fear that the honour of this Academy shall have been compromised by the recognition which the Council have thought it right on the present occasion to make, of that combination of genius and industry, which has already caused the researches of Kane to influence in no slight degree the progress of chemical science, and has won for him an European reputation.

The President then presented the Gold Medal to Dr. Kane, and the Academy adjourned for the summer.